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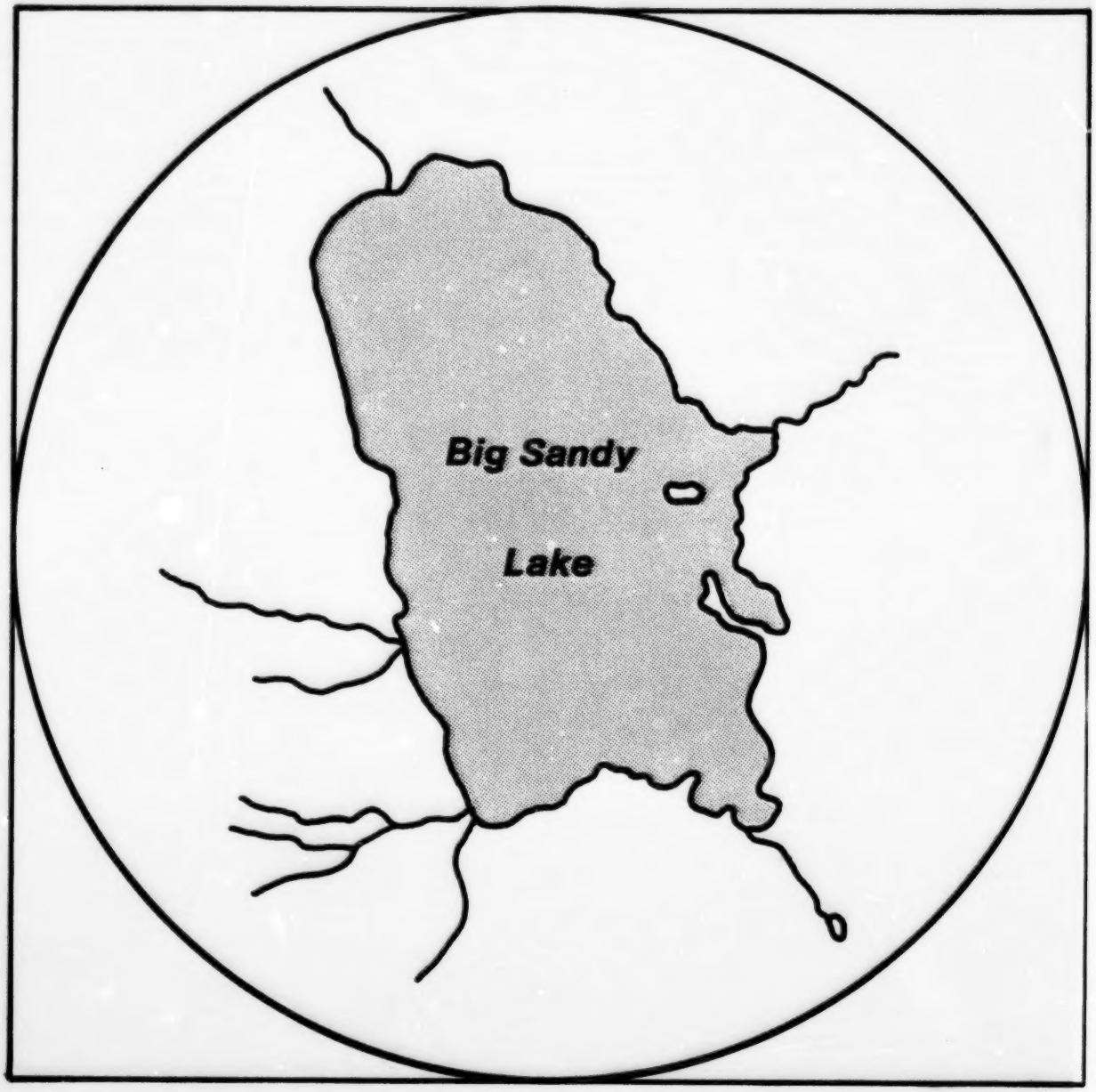
Fisheries

Big Sandy Lake Fisheries Management

Fisheries Management Report 88-2



BIG SANDY LAKE

BY

R.A. ORR

FISHERIES MANAGEMENT REPORT 88 - 2

FISHERIES BRANCH

SASKATCHEWAN PARKS, RECREATION AND CULTURE

BOX 3003

PRINCE ALBERT

EXECUTIVE SUMMARY

Situation

Big Sandy Lake supports both commercial and recreational fisheries. The commercial fishery has traditionally concentrated on whitefish, but recently increased its harvest of walleye, causing concern that this species may be in danger of overharvest and prompting a study of the lake in 1985.

The 1985 study was intended to determine the status of fish populations relative to a previous study in 1964, to determine present harvest rates and sustainable yield for each species of fish, and to determine if changes are needed in the management of commercial and recreational fisheries.

Results

The abundance and size of walleye and pike have decreased slightly since 1964. Populations of both species, nevertheless, remain stable. Total harvest of these species by both recreational and commercial fisheries is less than the estimated sustainable yield.

Whitefish populations appear stable, but the present harvest rate in the commercial fishery is slightly in excess of estimated sustainable yield.

The use of 11.4 cm mesh nets in the commercial fishery was investigated and determined to have no harmful effect on fish stocks.

Recommendations

Fish stocks at Big Sandy Lake are not presently in danger, but some recommendations should be implemented to ensure continued stability in this fishery.

1. The combined species quota in the commercial fishery should be converted to separate species quotas as follows:

   walleye - 3500 kg
   pike - 2000 kg
   whitefish - 5800 kg

2. Retain the minimum mesh size of 11.4 cm in the commercial fishery.

3. Continue monitoring commercial harvests to further assess the status of the whitefish population.

4. Continue to collect gut can data to monitor trends in angler harvest.

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1.0 INTRODUCTION

Big Sandy Lake is a large shallow lake important to both commercial and sport fisheries. Commercial fishing has been carried out for many years, with records dating to 1926. In 1963, construction of the Hanson Lake Road provided access for anglers, and an outfitting lodge and campground were subsequently established.

Present users of the fishery resource include commercial fishermen, outfitter guests, itinerant anglers utilizing the campground, and day users from the Nipawin Provincial Park area. Recreational fishermen utilize walleye and pike, while commercial fishermen harvest these species as well as whitefish.

The commercial fishery traditionally concentrated on whitefish but, during the 1984-85 season, commercial harvest of walleye increased considerably, creating concern that stocks may be in danger of overharvest. A study was therefore carried out in 1985 to:

- Determine the present status of the resource relative to an earlier study by C.B. Lane (1964-66).
- Determine present harvest rates and compare to estimates of potential yield.
- Determine management changes needed for commercial and sport fisheries.

2.0 MORPHOMETRY

Big Sandy Lake has an area of 8006 hectares, maximum depth of 12.2 metres, and mean depth of three metres. Almost 98% of the lake is shallower than ten metres (Lane, 1967).

3.0 LIMNOLOGY

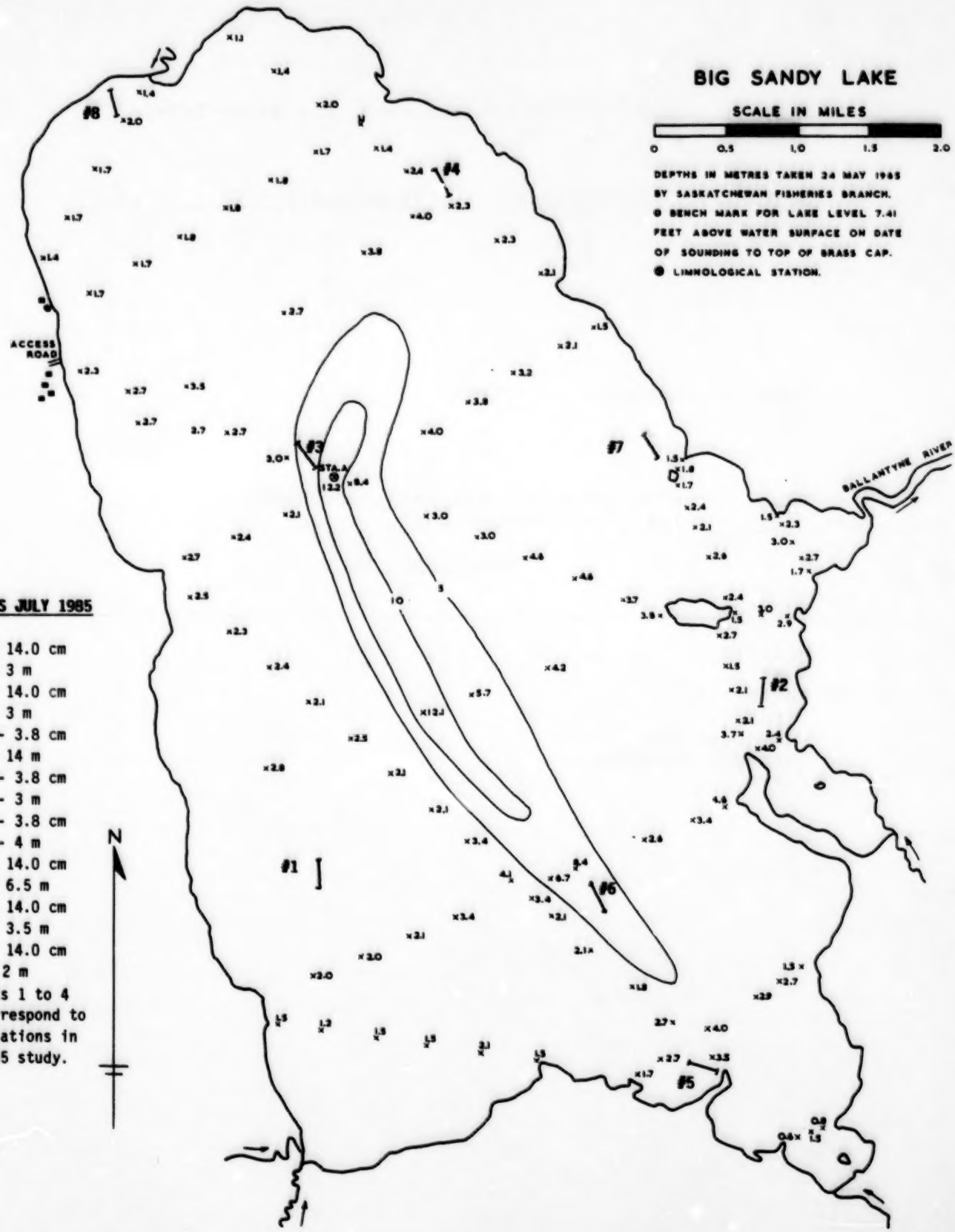
Oxygen, temperature and pH profiles were conducted at Station A (see Figure 1) on July 25, 1985. Results are shown in Table 1. The lake was thoroughly mixed at the time of examination with adequate oxygen for fish throughout the water column.

4.0 TEST NETTING SURVEY

Test netting was conducted on Big Sandy Lake, July 22 to 26, 1985. Eight 137-metre gangs, consisting of 3.8- to 14.0-cm mesh, were set at eight locations indicated in Figure 1. Net sets one to four correspond to locations used by Lane. Note that Lane used 274-metre gangs, therefore total yardage of net in both studies was the same.

Catch results are shown in Table 2. The most abundant fish numerically was the common sucker with 189

Figure 1.



NET SETS JULY 1985

#1 - 3.8 - 14.0 cm
3 - 3 m
#2 - 3.8 - 14.0 cm
3 - 3 m
#3 - 14.0 - 3.8 cm
7 - 14 m
#4 - 14.0 - 3.8 cm
3.5 - 3 m
#5 - 14.0 - 3.8 cm
1 - 4 m
#6 - 3.8 - 14.0 cm
6.5 - 6.5 m
#7 - 3.8 - 14.0 cm
3.5 - 3.5 m
#8 - 3.8 - 14.0 cm
1.5 - 2 m

Note: Sets 1 to 4 correspond to locations in 1965 study.

Table 1. Limnological observations, Big Sandy Lake, July 25, 1985.

Depth (m)	$[O_2]$ (ppm)	Temperature (°C)	pH
1	9.4	18	8.2
3	8.6	18	8.2
5	9.3	18	8.2
7	9.2	18	8.2
9	9.0	18	8.2
11	9.0	18	8.2

Depth at station - 12 metres.

Table 2. Fish catch in test nets, Big Sandy Lake, July 23-26, 1985.

	Mesh Size (cm)						
Species	1½	2	3	4	5	5½	Total
Walleye	23	61	49	39	6	2	180
Pike	14	61	23	3			101
Whitefish				1	1	1	3
Perch	55	79	12				146
Common sucker	4	11	38	131		5	189
Northern redhorse		1	1	5		4	11
Cisco	8	6	8	4			26

captured. Walleye were second in abundance at 180, while 146 perch and 101 northern pike were caught. Only three whitefish were captured in the nets.

Netting results from 1985 are compared to results from 1965 in Table 3. The most notable change is a decline in whitefish numbers from 30 in 1965 to 3 in 1985. Walleye numbers decreased by 10%, from 199 to 180. Pike declined by 20%, from 133 to 101. Cisco showed a moderate decline from 38 to 26.

Species showing increases in abundance were perch, from 47 in 1965 to 146 in 1985, and common sucker, increasing from 119 to 189. Numbers of northern redhorse sucker remained low, increasing from three to eleven.

A comparison is made of mean fork length and mean weight by species for 1965 and 1985 in Table 3. It is interesting to note that, with the exception of cisco, those species showing an increase in abundance in 1985 also show increases in mean length and mean weight. Those showing a decrease in numbers also show a decrease in size. Whitefish and northern redhorse sucker are not included in the comparisons due to small sample numbers. It is possible that changes in mean length and weight are related to degree of exploitation between 1965 and 1985. Species being exploited not only decrease in numbers, but also decrease in size due to selective cropping of older fish.

Table 3. Comparison of numbers and size of fish by species from test net catches, 1965 to 1985.

Species	Number		Mean Fork Length (cm)		Mean Weight (g)	
	1965	1985	1965	1985	1965	1985
Walleye	199	180	41.9	36.6	853	620
Pike	133	101	48.0	43.6	758	552
Whitefish*	30	3	-	-	-	-
Perch	47	146	15.5	18.1	54	96
Common Sucker	119	189	36.1	38.7	739	895
Northern Redhorse*	3	11	-	-	-	-
Cisco	38	26	16.5	22.9	73	259
Total	569	656				

* Insufficient samples for comparison of mean fork length and mean weight.

Of major importance to the Big Sandy Lake fishery are walleye, pike and whitefish. Status of these species is discussed in detail in succeeding sections.

4.1 Walleye

Walleye captured in 1965 averaged 41.9 cm fork length, while those captured in 1985 averaged only 36.6 cm. This may be due to the harvest of larger fish in the intervening years, but could also be due to the presence of a strong, younger age class in the present population.

Figure 2 depicts length distribution of walleye in 1985. In addition to a strong mode centred at 40 cm, there is a secondary mode centred at 24 cm. This could account for the smaller mean size of the present population.

Mean weight of walleye declined from 853 grams in 1965 to 620 grams in 1985. The reason for the decline would be the same as for the decline in mean length.

The age distribution of walleye in 1985 is shown in Figure 3. The modal age is 6+, with a secondary mode at 2+. The secondary mode supports the suggestion that the smaller size of walleye in 1985 is due to a strong, young age class. Conclusive evidence cannot be shown, however, as detailed data concerning age classes and length frequencies from 1965 are unavailable.

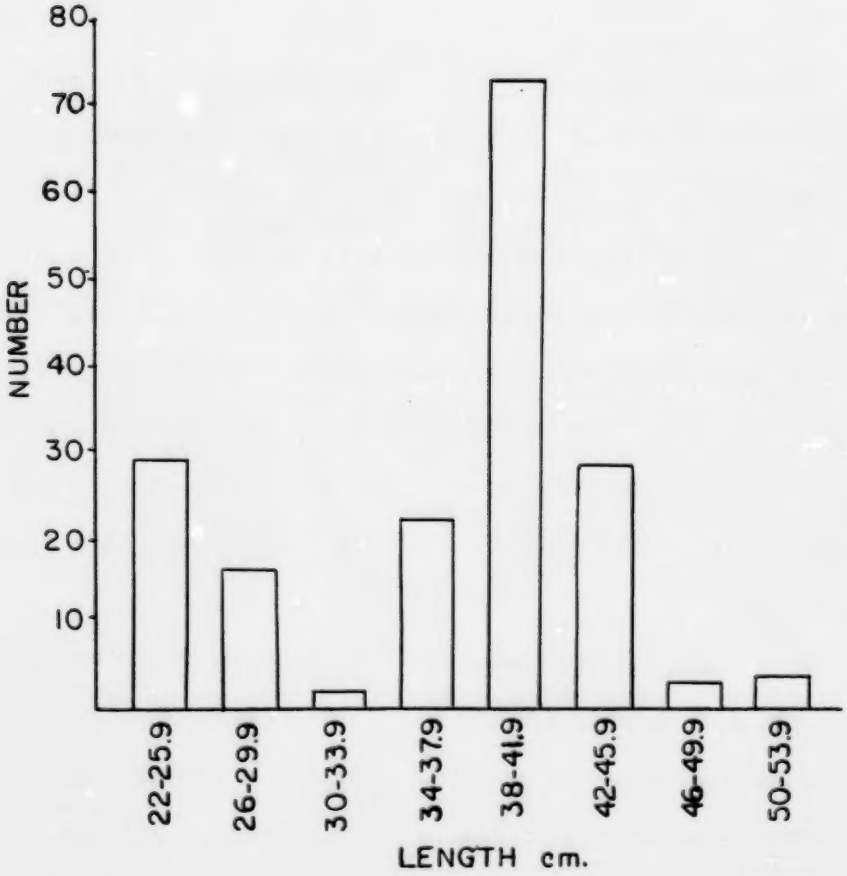


Figure 2. Length distribution of walleye, Big Sandy Lake, 1985

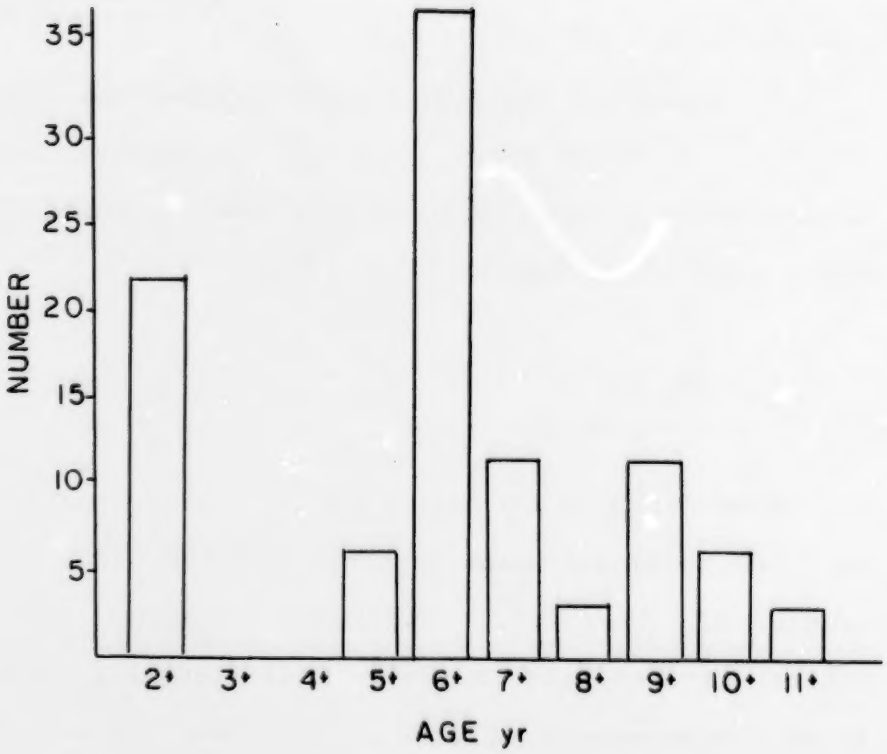


Figure 3. Age distribution of walleye, Big Sandy Lake, 1985

Several year classes of walleye are present, up to the age of 11+. Size at maturity (50% of samples mature) is about 390 cm fork length, corresponding to the modal age of 6+, thus, a significant percentage of walleye in the population are mature.

In summary, walleye abundance and mean size has decreased slightly since 1965 but the population appears to be fairly stable, with several year classes present, and a good proportion of mature fish.

4.2 Pike

Pike captured in test nets in 1965 averaged 48.0 cm fork length while those captured in 1985 had a mean fork length of 43.6 cm. Figure 4 depicts the length distribution of pike in 1985. Modal length is centred at 42 cm. Mean weight of pike in 1965 was 758 g. In 1985, mean weight was only 552 g. The reduction in mean length and weight is likely attributable to harvest of older fish in the intervening years.

Age distribution for pike in 1985 is shown in Figure 5. Modal and mean age is 5+. Several age classes are present in the population, ranging from 3+ to 14+.

Size at maturity (50% of samples mature) is about 42.0 cm fork length which corresponds fairly closely to the 4+ age class. Close to two-thirds of pike sampled were mature.

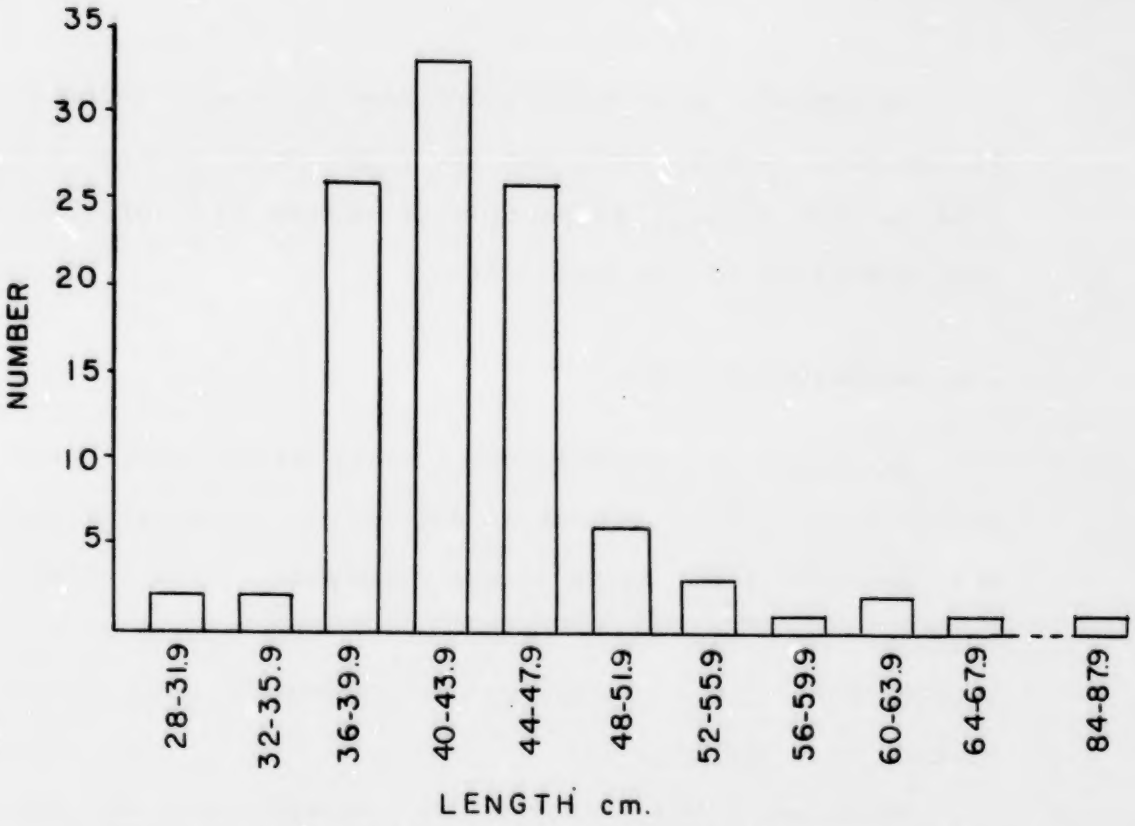


Figure 4. Length distribution of pike, Big Sandy Lake, 1985

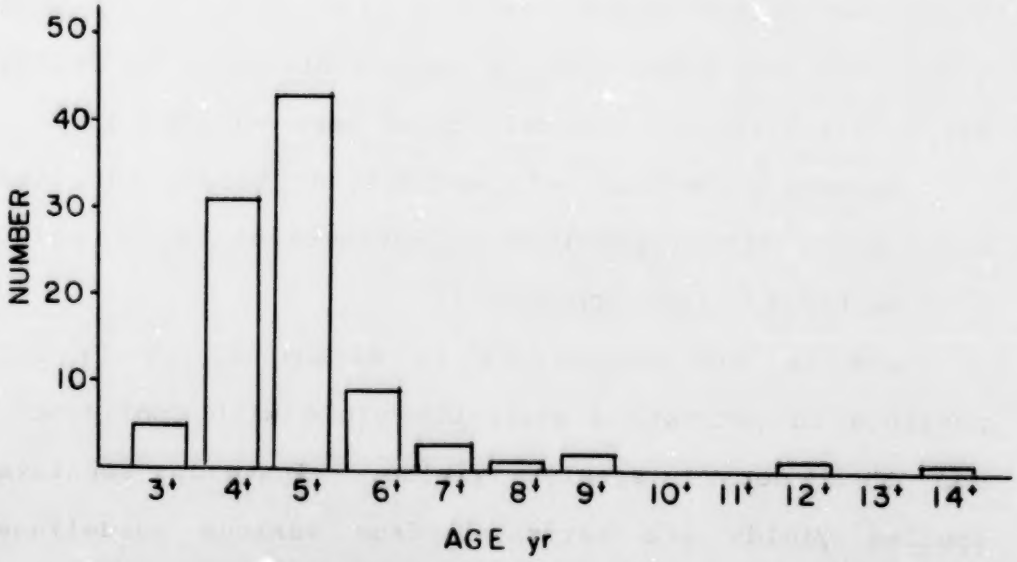


Figure 5. Age distribution of pike, Big Sandy Lake, 1985

In summary, pike numbers and mean size have declined in the past twenty years, but the presence of several age classes and a large proportion of mature fish provides some stability to the population.

5.0 SUSTAINABLE YIELD

Estimates of maximum sustainable yield (MSY) vary widely according to method of estimation. The estimated MSY derived from Ryder's morphoedaphic index (1965) suggests that Big Sandy Lake can produce approximately 72,800 kg/yr (8.7 kg/ha/yr) of commercial and sport species (see Appendix 1).

Matuszek (1978) showed the relationship between bottom fauna standing crop and long term harvest of major fish species in several North American lakes. Using the value for bottom fauna standing crop obtained by Lane (1967) for Big Sandy Lake, a sustainable yield of 36,800 kg/yr (4.6 kg/ha/yr) is calculated (see Appendix 1).

Rawsons's method of estimation based on lake morphometry (1952) provides an estimate of 58,700 kg/yr (7.3 kg/ha/yr) (see Appendix 1).

Due to the variability in estimates, it is not possible to estimate sustainable yield with confidence, and then derive species yields. Instead, separate species yields are estimated from various guidelines below, and compared in sum to the above estimates.

5.1 Walleye

Adams and Olver (1977) suggest a maximum yield of 1.25 kg/ha for productive shield lakes. Since Big Sandy Lake is a sedimentary lake and no doubt more productive than shield lakes, this value is considered to be a conservative estimate of walleye yield. For Big Sandy Lake, the potential yield is therefore estimated at 10,000 kg/yr.

5.2 Pike

Koshinsky (1979) suggested that pike harvests were sustainable at levels of 1.46 kg/ha for the 10-metre depth zone of Lac la Ronge. Virtually all of Big Sandy Lake is within the 10-metre depth zone. Using the above guideline, potential yield for pike is estimated at 11,500 kg/yr.

5.3 Whitefish

No guidelines have been developed for whitefish productivity. Whitefish harvest by the commercial fishery has been fairly stable through the lake's history and could be considered a reliable indicator of potential yield. The twenty-five year average production is 6,355 kg, or 0.8 kg/ha/yr.

5.4 Comparison to Estimates of MSY

Potential yield by species for Big Sandy Lake are as follows:

Walleye	10,000 kg/yr
Pike	11,500 kg/yr
Whitefish	6,400 kg/yr
Total	27,900 kg/yr

The total species yield of 27,900 kg/yr is considerably less than all estimates of sustainable yield obtained in Section 5. However, these estimates are likely over optimistic. Large areas of Big Sandy Lake are shallow and weedy, which could result in high water temperatures and low oxygen levels in summer, and low oxygen levels in winter. This stress could conceivably lead to lower fish production. Thus, the value of 27,900 kg/yr is considered a more reasonable, though somewhat conservative, estimate of sustainable yield.

6.0 HARVEST

6.1 Commercial Harvest

Commercial harvest records for Big Sandy Lake date back to 1926 (Appendix 2). The major species harvested is whitefish, accounting for 80% of harvest, historically.

Average annual harvest by species during the past five years and the past 25 years are as follows:

	5-Year Mean (kg)	25-Year Mean (kg)
Walleye	2,992	1,753
Pike	1,216	843
Whitefish	7,147	6,221
Total	11,355	8,817

6.2 Recreational Harvest

6.2.1 Summer Harvest

Estimates of angling harvest during the summer period were obtained by monitoring gut cans and interviewing anglers at the lake (See Appendix 3 for interview form).

Gut cans are located at the D.P.R.C. filleting shed and at the outfitter camp. Records were maintained of the volume, by species, of fish offal emptied from each location, which was then converted to an estimate of round weight of fish harvested (Appendix 4). Angler interviews determined the percentage of anglers utilizing the gut cans, and harvest estimates were adjusted accordingly. Gut can records were maintained in 1985 and 1986, while angler interviews were conducted in 1985 only.

Game fish harvest (kg) during the May to August period in 1985 and 1986 is estimated as follows:

	1985	1986	Mean
Walleye	1435	1793	1614
Pike	3395	2147	2771

Little angling activity takes place in the fall, therefore the above estimates account for most fish harvested during the open water period.

6.2.2 Winter Harvest

Winter angling harvest was estimated by means of angler interviews on the lake. Officers made three visits to the lake in December 1985, and found no anglers present. A nil harvest estimate is made for the month of December.

One visit to the lake on January 18, 1986 (a Saturday), was conducted, on which 25 anglers were present and interviewed.

The catch per angler hour, by species, was calculated, and projected over the number of hours the anglers intended to fish that day to obtain an estimate of the number of fish harvested. No further angler checks were made during the winter, therefore in making an estimate of the total number of fish harvested that winter, the following assumptions are made:

- Angler numbers and success rates on January 18 are representative of all weekends from January 1 to March 31.
- Angling activity on week days from January 1 to March 31 is close to nil.

To obtain an estimate of the weight of fish harvested, it is assumed that fish angled in the winter are similar in size to fish angled in the summer. From the gut cans, an average length of angled fish for each species was determined. Using the length-weight relationships derived from test net catches, mean weights for angled walleye and pike were then calculated.

Detailed calculations of walleye and pike harvest in the winter fishery are shown in Appendix 5. A very small number of perch were captured in the winter fishery and are not included in the calculations.

Bearing in mind that projections were made from a small number of interviews, which may lead to considerable error, winter harvest estimates are as follows:

Walleye - 1130 kg

Pike - 555 kg

6.2.3 Total Angler Harvest

Angler harvest at Big Sandy Lake is estimated at approximately 2700 kg walleye and 3300 kg pike. The breakdown by season is shown in Table 4.

6.3 Total Harvest Estimate

Total estimated harvest by species is shown below:

Walleye - 5700 kg

Pike - 4500 kg

Whitefish - 7100 kg

Total - 17,300 kg

Table 4 shows the breakdown by commercial and recreational fisheries.

6.4 Comparison of Harvest To Sustainable Yield

Walleye harvest by all users is estimated at approximately 5700 kg/yr while sustainable yield is estimated at 10,000 kg/yr, leaving a surplus of 4300 kg/yr.

Pike harvest is estimated at about 4500 kg/yr, less than half the estimated sustainable yield of 11,500 kg/yr.

The whitefish harvest rate is about 7100 kg/yr, which is greater than the estimated sustainable yield of 6400 kg/yr.

Total harvest of all species is estimated at 17,300 kg/yr. This is well below all estimates of maximum sustainable yield. Present harvest rates at Big Sandy

Table 4. Harvest (kg) estimates, Big Sandy Lake

Species	Recreational			Commercial**	Total
	Summer*	Winter	Total		
Walleye	1614	1130	2744	2292	5736
Pike	2771	555	3326	1216	4542
Whitefish	--	--	--	7147	7147
Total	4385	1685	6070	11,355	17,425

* Mean value from 1985 and 1986.
** Five year mean 1982 to 1986.

Lake do not appear to be excessive, with the possible exception of whitefish, which is being harvested slightly above the long term average.

7.0 COMMERCIAL FISHERY

Records of commercial fishing on Big Sandy Lake date back to 1926-27 (Appendix 2). The lake has been fished in all but eleven years since then, and has been fished steadily since 1977. At present, five commercial fishing licences are issued annually.

The commercial quota is 11,300 kg, which includes whitefish, pike and walleye. The lake quota was formerly 18,100 kg but was reduced in 1968, as recommended by Lane. The legal mesh size was originally 12.7 cm but was reduced to 11.4 cm following Lane's study. Whitefish are classed as cutters (more than 80 cysts/45 kg).

7.1 Quota

A comparison of estimates of sustainable yield to harvest indicates that fish stocks of Big Sandy Lake are not being overharvested at present, therefore there is no need for a reduction in the commercial quota. However, to prevent overharvest of individual species, quotas should be species specific.

Two approaches may be considered in adjusting the commercial quota - a game fish tolerance or separate species quotas. Where a tolerance is applied, a maximum percentage of game fish is allowed in the daily catch. This system works well if whitefish are of export quality and therefore fairly valuable. However, where whitefish are classified as cutters and are of considerably less value, a tolerance reduces the economic viability of the fishery by requiring a high daily catch of whitefish relative to other species. On cutter lakes, separate species quotas are preferable for economic reasons.

In recommending quota levels, consideration is given to estimates of sustainable yield and present harvest levels. In addition, it is recognized that the commercial fishery is one of two major fisheries on the lake and should be treated on similar terms as the recreational fishery.

The recommended commercial quota for walleye is 3500 kg. This value is above the 5-year mean harvest level, and approximately twice the long-term harvest level. This quota represents about 35% of the estimated sustainable yield of that species.

A pike quota of 2000 kg is recommended. This is above the 5-year mean, and about twice the long-term mean harvest level. The recommended quota represents 20% of the estimated sustainable yield of pike.

Both walleye and pike harvests have increased during the past few years, and the five-year means are nearly double the long term (25-year) means. Recommended quotas thus reflect more recent activity on the lake, but are well within sustainable yields and are similar to recreational harvests.

The recommended quota for whitefish is 5800 kg, which is similar to the long-term harvest rate for this species. The overall quota remains at 11,300 kg.

7.2 Mesh Size

7.2.1 Effect On Walleye

The legal mesh size in the Big Sandy commercial fishery is 11.4 cm. Concern has been expressed that these nets may harm walleye populations by capturing younger walleye that have not yet matured. This question was considered for lakes in the Sandy Bay area by Liaw (1985). In that study it was found that 11.4-cm mesh nets captured no immature walleye, with the mean size of walleye captured in commercial nets significantly greater than the size at maturity.

Limited data exist for a similar comparison at Big Sandy Lake. Sixteen walleye captured in commercial nets in 1986 were measured and compared to size at maturity

data obtained during test netting in 1985. Mean fork length of these fish was 44.8 cm, with the smallest being 39.8 cm. Size of maturity is 39.0 cm fork length.

It should be noted that commercial fishermen at Big Sandy do not use 11.4-cm mesh nets exclusively. Rather, this mesh size is used for efficient walleye harvest, while 12.7-cm mesh nets are used in areas of whitefish concentrations. Thus, the above discussion compares not the state of maturity of fish caught in 11.4-cm mesh nets, but the state of maturity of fish in the particular mix of 12.7-cm and 11.4-cm mesh nets used on the lake. If 11.4-cm mesh nets were used exclusively, the mean size of harvested fish would be closer to the size at maturity.

Liaw recommends that size at maturity be recognized as the minimum size at first capture in a commercial fishery. At Big Sandy Lake, no walleye examined in the commercial catch were below the size at maturity. Use of 11.4-cm mesh nets should not harm the walleye population, provided that a realistic quota is in place.

7.2.2 Effect On Pike

The mean size at maturity for pike is 42.0 cm. A small sample (7) from the commercial catch showed a mean

size of 62.9 cm, suggesting that the nets presently in use at Big Sandy Lake have no harmful effect on this species.

7.3 Whitefish Status

The small number of whitefish captured in test nets suggests a very low population is present. However, relatively consistent harvest of this species historically suggests a stable population. To better assess the whitefish population, the commercial catch was sampled in 1985 during the October fishery to obtain age and growth data.

7.3.1 Age Structure

Scale samples for ageing purposes were obtained from 64 whitefish. Age frequency is shown in Figure 6. Seven age classes were present in the commercial catch, ranging from age 4+ to 10+. A minimum of three age classes is needed for a stable whitefish fishery (Dean 1976). This requirement is clearly met in this population.

Modes appear at ages 5+ and 8+. This may indicate strong year classes, but may also be simply a function of low sample numbers.

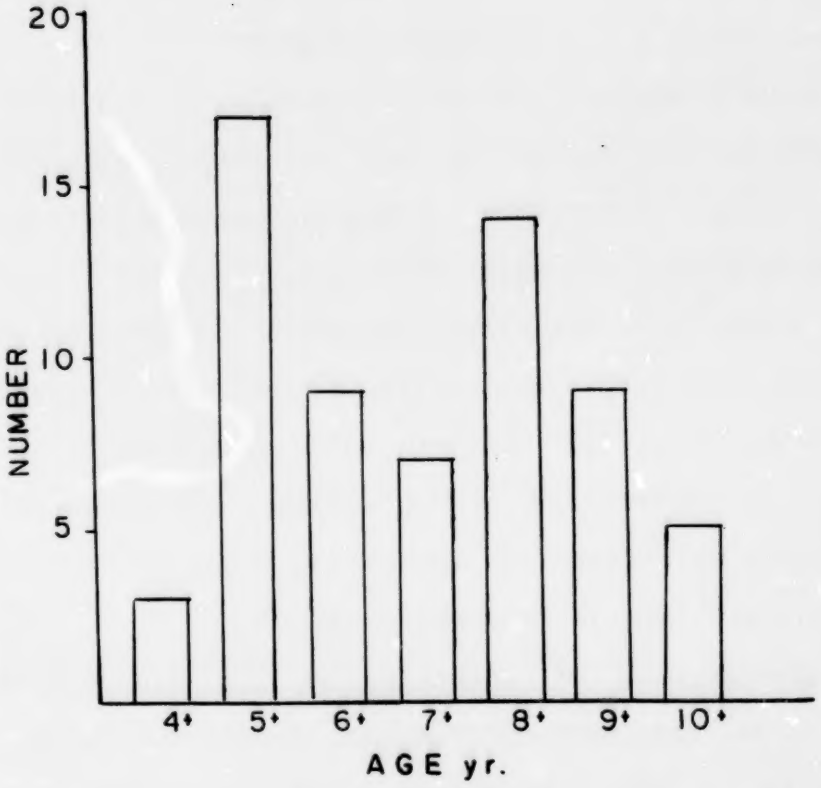


Figure 6 Age frequency of whitefish in the commercial catch Big Sandy Lake 1985

7.3.2 Growth Rate

Stable whitefish populations under light exploitation are characterized by low growth rates, while high growth rates indicate greater exploitation (Healey 1975). Figure 7 depicts growth of whitefish in Big Sandy Lake in terms of length at age in 1985, from the commercial catch. Comparison is made to two other lakes, Candle and Jackfish, for which similar data exist.

The Candle Lake whitefish population is considered to be moderately exploited, with a low growth rate. Jackfish Lake whitefish in 1970 also exhibited a low growth rate characterizing low or moderate exploitation. By 1980, these whitefish were exhibiting signs of heavier exploitation with a higher growth rate.

The growth rate of whitefish at Big Sandy Lake appears to be intermediate between growth rates for Jackfish Lake in 1980, and growth rates for Candle Lake in 1980, and Jackfish Lake in 1970. Although whitefish growth rates at Big Sandy are fairly high, the population is not being exploited to the same degree as Jackfish Lake in 1980, at which time the population was declining. Further sampling of whitefish should be conducted in future years to monitor trends in growth rate. This will allow on-going evaluation of the whitefish limit.

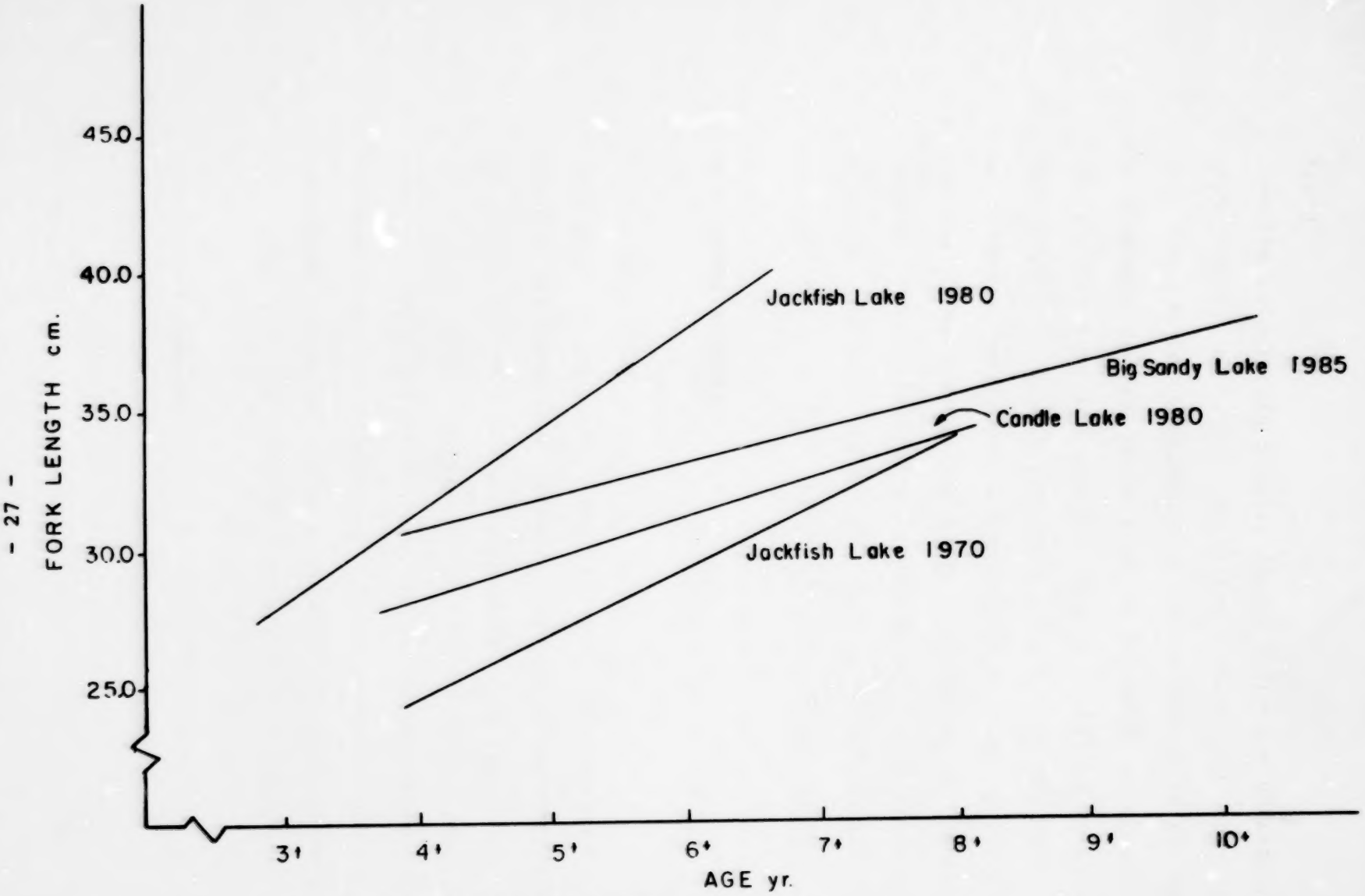


Figure 7 Comparison of length at age for whitefish

7.3.3 Summary

Test netting results indicate a low population of whitefish; however, harvest records and age composition suggest that the population remains stable. Growth of fish indicates moderate exploitation of the population.

While most indicators do not suggest that the whitefish population is endangered, the poor test net results are cause for concern. Continued monitoring may indicate if further restrictions on harvest are necessary.

8.0 SPORT FISHERY

Harvest of game fish by the sport fishery is somewhat greater than by the commercial fishery. However, both fisheries together harvest only about half the estimated sustainable yield. Consequently, there is no need for additional restrictions on sport fishing on this lake. To ensure that overharvest does not occur in the future, some restrictions should be placed on future development of the sport fishing industry on the lake. That is, future development proposals should be reviewed with regard to their potential impact on the fish resource to maintain harvest levels below the sustainable yield.

9.0 RECOMMENDATIONS

1. The combined species quota in the commercial fishery should be converted to separate species quotas as follows:

   walleye - 3500 kg

   pike - 2000 kg

   whitefish - 5800 kg

2. Retain the minimum mesh size of 11.4 cm in the commercial fishery.

3. Continue monitoring commercial harvests to further assess the status of the whitefish population.

4. Continue to collect gut can data to monitor trends in angler harvest.

5. Future recreational development proposals should be carefully assessed to ensure that over-development does not occur.

10.0 REFERENCES

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Appendix 1. Estimates of Maximum Sustainable Yield

a) Ryder's morphoedaphic index

Lake area - 8006 ha (Lane, 1967)
Mean depth ($\bar{z}$) - 3.0 m (Lane, 1967)
TDS - 190 ppm (Lane, 1967)

$$MEI = \frac{TDS}{\bar{z}} = \frac{190}{3.0} = 63.3$$

$$Y = 1.4\ (MEI)^{0.45}$$
$$= 1.4\ (6.47)$$
$$= 9.1 \text{ kg/ha/yr}$$
or 72,800 kg/yr

b) Rawson's morphometric method

$\log\ (y - 0.56) = 1.1677 - 0.7029 \log \bar{z}$
where Y is sustainable fish yield (kg/ha/yr)
and $\bar{z}$ is mean depth in metres

$\log\ (Y - 0.56) = 1.1677 - 0.7029 \log\ (3.0 \text{ m})$
$\log\ (Y - 0.56) = .8303$
$Y - 0.56 = 6.77$
$Y = 7.33$ kg/ha/yr
or 58,700 kg/yr

c) Matuszek's bottom fauna method

$CT/A = -0.6665 + 5.0748 \log BFWT$
where CT/A is predicted fish yield in kg/ha/yr
and BFWT is standing crop of benthic fauna in kg/ha

$CT/A = 0.6665 + 5.0748 \log\ (10.8)$
$= 4.6$ kg/ha/yr
or 36,800 kg/yr

Appendix 2. Commercial production records

Year	Whitefish	Walleye	Pike	Total
1926-27	8162	561	619	9342
1927-28	3439	44	1320	4803
1928-29	545	18	1334	1897
1934-35	3084	-	91	3175
1935-36	8165	23	136	8324
1937-38	10886	816	1270	12972
1938-39	22535	144	3267	25946
1939-40	15643	42	2087	17772
1940-41	7632	35	1915	9582
1941-42	3974	20	1397	5391
1942-43	4026	113	1497	5636
1943-44	7490	52	1240	16324
1947-48	4536	48	227	4811
1949-50	10560		155	10715
1950-51	8656		212	8868
1951-52	12262	-	272	12534
1952-53	10574	32	649	11255
1953-54	5829	22	689	6540
1954-55	2429	3	484	2916
1955-56	7507	45	648	8200
1956-57	11674	627	1074	13375
1957-58	10901	379	1457	12737
1958-59	12431	382	1510	14323
1959-60	16033	486	613	17132
1960-61	18253	386	778	19417
1961-62	15990	479	489	16958
1962-63	10469	180	513	11162
1963-64	11472	681	1380	13533
1964-65	9713	741	889	11343
1965-66	6046	993	794	7833
1966-67	5223	571	842	6636
1967-68	4968	4277	503	9748
1968-69	3990	4044	653	8687
1969-70	1646	1746		3392
1970-71	4968	2924	638	8530
1971-72	2548	3944	1086	7578
1972-73	383	89	25	497
1975-76	1017	488	258	1763
1976-77		181		181
1977-78	363	1553	231	2147
1978-79	2894	1506	1203	5603
1979-80	6586	504	1002	8092
1980-81	7103	1682	1788	10573
1981-82	6169	1887	1934	9990
1982-83	11842	1393	1813	5048
1983-84	6032	2167	1108	9307
1984-85	4742	5311	880	10933
1985-86	6374	4161	896	11431
1986-87	6745	1927	1385	10057

Appendix 3. Angler survey form.

ANGLER SURVEY - BIG SANDY LAKE

DATE _____ NO. OF ANGLERS IN PARTY _____

RESIDENCE _____ ACCOMMODATION (SPECIFY) _____
(Home Town) OR DAY VISIT

NUMBER OF FISH KEPT PIKE _____ PERCH _____

WALLEYE _____ OTHER _____

NUMBER OF FISH RELEASED PIKE _____ PERCH _____

WALLEYE _____ OTHER _____

HOURS FISHED _____ ADDITIONAL HOURS TO BE FISHED _____
(Ask Angler to Estimate)

WHAT FISH CLEANING FACILITY WILL BE USED? - i.e., DPRR, Outfitter or

Other (Specify) _____

WHAT FISH SPECIES DO YOU PREFER TO CATCH IN BIG SANDY LAKE?

_____

Appendix 4. Calculation of Summer Angling Harvest

1. 1985

DPRR gut cans - 17 gallon capacity (equivalent to 90 kg round weight)

Month	Number of Cans	Total Weight(kg)	Weight by Species(kg) Pike	Walleye
*May	5.6	504	378	126
June	18.1	1629	904	725
July	7.4	666	616	50
August	2.5	225	222	3
Total	33.6	3024	2120	904

*No records. Figures shown are estimates prorated from outfitter results and June figures.

Outfitter gut cans - 5 gallon capacity (equivalent to 27 kg round weight)

Month	Number of Cans	Total Weight(kg)	Weight by Species(kg) Pike	Walleye
May	8	216	162	54
June	26	702	421	281
July	9	243	226	17
August	1.5	41	41	
Total	44.5	1202	850	352

Appendix 4, continued

Combined DPRR and Outfitter Records:

Month	Total Weight(kg)	Pike(kg)	Walleye(kg)
May	720	540	180
June	2331	1325	1006
July	909	842	67
August	266	263	3
Total	4226	2970	1256

Eighteen angler interviews were conducted during the summer, with 87.5% of anglers utilizing either DPRR or outfitter gut cans. Total summer harvest is therefore adjusted as follows:

$$\text{Walleye} - \frac{1256 \text{ kg}}{.875} = 1435 \text{ kg}$$

$$\text{Pike} - \frac{2970 \text{ kg}}{.875} = 3395 \text{ kg}$$

2. 1986

In 1986, DPRR and outfitter gut can records were combined:

Month	Total Weight(kg)	Weight by Species(kg) Pike	Walleye
May	451	293	158
June	1965	653	1312
July	716	635	81
August	316	298	18
Total	3448	1879	1569

Appendix 4, continued

Using the same gut can utilization percentage as in 1985, harvest figures are adjusted as follows:

Walleye - $\frac{1569}{.875}$ = 1,793 kg

Pike - $\frac{1879}{.875}$ = 2,147 kg

Mean harvest by species, 1985 and 1986:

Walleye - 1,614 kg

Pike - 2,771 kg

Appendix 5. Calculation of Winter Angling Harvest

1. Number of fish, by species, harvested during winter period.

   Actual catch per angler-hour calculated from angler interview forms for January 18, 1986:

   Walleye - .39

   Pike - .25

   Projected angler-hours for January 18 (number of anglers x average number of hours to be fished): 151

   Projected angler harvest for January 18:

   Walleye - .39 x 151 = 59

   Pike - .25 x 151 = 38

   Assume harvest on weekends occurs at this rate, and negligible harvest occurs during the week, for the period January 1 to March 31.

   Walleye - 59 x 2 days/weekend x 13 weekends = 1,534

   Pike - 38 x 2 days/weekend x 13 weekends = 988

2. Weight of fish, by species, harvested during the winter period.

   Assume the mean weight of winter-angled fish is the same as summer-angled fish.

   a) Walleye

   Length-weight relationship:

   $W = 0.000005328L^{3.12877132}$ ($r^2 = 0.9899$)

   Mean length (from gut cans) - 40.0 cm
   Weight at 40.0 cm - 737 g
   Harvest during winter period:
   1,534 walleye x 737 g/walleye = 1,130 kg

   b) Pike

   Length-weight relationship:

   $W = 0.000015822L^{2.842549094}$ ($r^2 = 0.9685$)

   Mean length (from gut cans) - 45.3 cm
   Weight at 45.3 cm - 562 g
   Harvest during winter period:
   988 pike x 562 g/pike = 555 kg